Missouri Department of Natural Resources
Water Pollution Control Program

Total Maximum Daily Loads (TMDLs)

for

North Moreau Creek
Moniteau County, Missouri

Completed July 22, 1999
Approved December 1, 1999

North Moreau Creek [Missouri] TMDLs (Total Maximum Daily Load) For Suspended Algae (NFR), Carbonaceous Biological Oxygen Demand (CBOD), and Ammonia (NH3 as N) (three TMDLs total)

Name: North Moreau Creek

Missouri WBID: 0942

Class: P

Beneficial Uses: Livestock and Wildlife watering, Warm Water Aquatic life, Fish Consumption, Swimming, and Recreation

Size of Impaired Segment: 10 miles

Location of Impaired Segment: from SE1/4 S-4, T-44N, R-5W to SW1/4 S-20, T-44N, R-14W

Pollutants: Suspended Algae (NFR) documented
Carbonaceous biological oxygen demand (CBOD)
Ammonia (NH_3) not documented but possible

Pollutant Source: California South Wastewater Lagoons (CSWL)

TMDL Priority: High

1. Description of Waterbody, Pollutant of Concern, Pollutant Sources and Priority Ranking

North Moreau Creek, WBID 0942, is a class P stream. Class P streams maintain permanent flow even in drought periods. The impaired segment of this stream is 10 miles long and extends from SE1/4 S-4, T-44N, R-15W to SW1/4 S-20, T-44N, R-14W in Moniteau County. This segment appears on the Section 303(d) list with NFR as the pollutant. The pollutant of concern in the impaired segment is Suspended Algae discharged by the lagoons, CBOD and ammonia are possible pollutants. The sole pollutant sources are the three California South Lagoons – a wastewater treatment system.

This submittal contains three TMDLs, the one listed for NFR is required; the other two for CBOD and ammonia are being submitted by Missouri as Section 303(d)(3) TMDLs, which do not require EPA review and approval. The TMDL priority for this segment is high.

The California South lagoon system consists of three lagoons with individual discharges into North Moreau Creek. The west lagoon is a three-cell lagoon with a surface area of 25 acres and a design flow of about 0.9 MGD. The middle lagoon is a three-cell lagoon with a surface area of 68 acres and a design flow of 1.4 MGD. The east lagoon has two aerated cells operated in series followed by a polishing cell. It has a surface area of 18 acres and a design flow of 1.2 MGD. The total system has a nominal dry weather capacity of 3.5 MGD.

The present NPDES permit prohibits discharge during the summer. This condition was included to reduce the impacts of discharge on the stream during a time when in-stream dilution and in-stream dissolved oxygen levels were lowest. In spite of these provisions, there were chronic problems with high levels of algae in the receiving stream and numerous complaints from the public about the green appearance of the stream.

2. Description of the Applicable Water Quality Standards and Numeric Water Quality Target

The designated beneficial uses of North Moreau creek are general warm-water fishery (human fish consumption), livestock and wildlife watering, whole body contact recreation and boating. The impaired use is protection of aquatic life.

Non Filterable Residues (NFR): Narrative standards for NFR are covered under the general criteria in the state Water Quality Standards under 10 CSR 20-7.031. Section (3)(A) states that " Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent maintenance of full beneficial use." Section (3)(C) states that "Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full beneficial use." Since the standard is narrative, an interpretation is needed to link it to a numeric criterion that is used to determine when water quality standards are met. This TMDL establishes this numeric criterion based on experience at other relatively large wastewater discharges. This experience has shown that a limit of 35 mg/l of suspended solids in winter and spring, and 25 mg/l in summer and fall, are protective of aquatic life uses. This numeric criterion and the flow may be used to determine the loading capacity, which then may be allocated to the sources of the pollutant.

Ammonia: Missouri's Water Quality Standards, 10CSR20-7.031 Table B, lists the chronic ammonia limits for general warm-water fisheries. These limits are pH and water temperature dependent. Seasonal ammonia limits and the typical seasonal pH and water temperature values are:

Period	Temperature	pH	Ammonia (mg/l)
July 1 – Oct. 31	26C	7.8	1.2
Nov 1 – Mar 31	4C	7.8	2.1
April 1 – June 30	14C	7.8	2.0

CBOD: There is no numeric criterion in Missouri's water quality standards for CBOD. Since the effect of CBOD is to exert oxygen demand on the receiving waterbody, dissolved oxygen is the surrogate of concern. State water quality standards call for the maintenance of 5 mg/l or the normal background level of dissolved oxygen, whichever is lower.

Antidegradation Policy

Missouri's water quality standards include the EPA "three-tiered" approach to antidegradation.

Tier 1 defines baseline conditions for all waters. It requires that existing beneficial uses be protected. TMDLs would normally be based on this tier, assuring that numeric criteria such as dissolved oxygen and ammonia concentrations are met to protect uses.

Tier 2 requires no degradation of high-quality waters, unless limited lowering of quality is shown to be necessary for "economic and social development." A clear implementation policy for this tier has not been developed, although if sufficient data on high-quality waters are available, TMDLs could be based on maintaining existing conditions, rather than the minimal Tier 1 criteria.

Tier 3, the most stringent tier, applies to waters designated in the water quality standards as outstanding state and national resource waters. Tier 3 requires no degradation under any conditions. Management may require no discharge or prohibit certain polluting activities. TMDLs would need to assure no measurable increase in pollutant loading.

These TMDLs satisfy Tier 1, because after implementations the beneficial uses will be protected.

3. Loading Capacity – Linking Water Quality and Pollutant Sources

The loading capacity (LC) is the greatest amount of loading that a water can receive without violating water quality standards (40 CFR 130.2(f)). When the water body has little or no nonpoint source loads and the point source facilities have relatively constant discharge flows, then the loading capacity depends on the flow of the water body. The flow condition most likely to accompany an exceedence of applicable water quality standards occurs under low flow conditions. Under these conditions, there is less water available to dilute the pollutant so that water quality standards are met at the end of the mixing zone. These TMDLs are established at the critical low flow conditions.

Missouri's Water Quality Standards, 10CSR20-7.031 in section (4)(A)1 notes that a special case occurs when stream flows are less than the 7Q10 low flow value (the lowest average flow for seven consecutive days with a recurrence interval of ten years). Missouri DNR has used this section of the standards to define critical (worst case flow conditions, or design flow conditions) flow for point source discharge of pollutants to be the 7Q10 low flow.

The loading capacities of pollutants are based on the applicable water quality standards and the flow of the stream at the critical flow condition. When statutes allow a mixing zone to a facility discharge, the loading capacities are calculated at the end of the facility discharge pipe, such that the water quality standards are met at the end of the mixing zone.

For CBOD and Ammonia, load capacities and point source load allocations are usually accomplished using the Qual2e model. Estimates of NFR load capacities and point source load allocations are based on empirically derived numbers. This empirical approach, where these limits were developed interactively over many years for common types of waste water treatment facilities, is based on the relationship of the observed instream conditions downstream of specific wastewater discharges and the permit limits for those facilities.

Empirically derived limits for NFR are based on a review made during the past year by DNR. This review looked at the presence or absence of deposited solids in streams below 256 wastewater treatment facilities, 179 sewage lagoons and 77 mechanical plants. NFR permit limits in lagoons are typically 60-80 mg/l while those for mechanical plants are almost always 30 mg/l with a few plants having 45 mg/l. Deposited solids judged to be in excess of state water quality standards were present below 49 lagoons (27%) but only two of the mechanical plants (3%). These findings support our belief that 30 mg/l NFR should be protective of state water quality standards.

Missouri believes that these empirical limits are sufficiently robust to assure that when applied to a particular type of facility, the applicable water quality standards will be met. Since this TMDL is "phased" or iterative in nature, any errors caused by this empirical process would be corrected in later phases.

In the case of North Moreau Creek, the Qual2e model was not employed because the California South facility was not allowed to discharge wastewater during design low flow conditions. Thus, no field data was available to calibrate or verify a model at this critical period. Review of other stream models of wastewater discharge to other small Missouri stream and appropriate effluent limits predictions by those models were used to empirically set CBOD and Ammonia limits for the California South lagoons and estimate load capacities of North Moreau Creek. The summary of the point source load allocation recommendation from those models is attached as Appendix One.

The limits for ammonia and BOD were based on typical advanced waste treatment limits needed at other facilities discharging relatively large volumes of effluent to streams with little or no dry weather dilution capacity.

	CBOD5 (mg/l)	NFR (mg/l)	NH_3N (mg/l)
July 1- Oct. 31	10	20	1.4
Nov.1 – March 31	25	30	3.0
April 1- June 30	25	30	3.0

The loading capacity in pounds per day at end-of-pipe is calculated by

(advanced treatment limit concentration, mg/l) (discharge flow, cfs) (5.4) = loading capacity

The effluent flow is 5.42 cfs year round, and the resulting loading capacity at end-of-pipe is summarized in the table below

END-OF-PIPE LOADING CAPACITIES

	CBOD5 (lb/da)	NFR (lb/da)	NH_3N (lb/da)
July 1- Oct. 31	293	585	41
Nov.1 – March 31	732	878	88
April 1- June 30	732	878	88

For comparison, the load capacity for ammonia at the end of the mixing zone may be calculated from the following formula, with the results provided in the table below:

(NH_3N WQS criterion in mg/l)(Flow in cfs)(5.4) = Load Capacity in lb/day[2]

END-OF-MIXING ZONE LOADING CAPACITIES

	Effluent Flow (cfs)	Stream 7Q10 Low Flow (cfs)	NH_3N WQS Value (mg/l)	NH_3N Load Capacity (#/day)
July 1 - Oct.31	5.42	0.00	1.2	35.1
Nov. 1 - April 1	5.42	2.00	2.1	84.1
April 1 - June 30	5.42	2.00	2.0	80.1

As can be seen in the above two tables, comparing the loading capacity at the end of the pipe with the loading capacity at the end of the allowed mixing zone, the empirically derived numbers are reasonable considering that some ammonia is not conserved when traveling from the end of the pipe to the end of the mixing zone.

4. Load Allocations (LA)

Missouri is establishing that the load allocations for the three pollutants are the actual background loadings under the critical flow conditions.

The upstream nonpoint source load comes from pasture and crop fields, farmsteads, roads, road ditches and woodlots. The nonpoint source load is estimated by using observed dry weather ammonia, CBOD and NFR concentrations in North Moreau Creek upstream of the California South lagoons and the 7Q10 stream low flow values for each season. The calculation uses the same formula as Formula 3 except the concentration and flow values are those of the stream rather that the effluent from the WWTP. The table below summarizes these calculations.

[2] The constant 5.4 is a conversion factor that gives the results in pounds per day

	In-stream Concentration (mg/l)			In-stream Flow (cfs)	Nonpoint Source Load Allocation (#/day)		
	CBOD	NFR	NH_3N		CBOD	NFR	NH_3N
July 1 - Oct. 31	2	3	0.02	0.0	0.0	0.0	0.0
Nov.1 – Mar.31	2	3	0.02	2.0	21.6	32.4	0.2
April 1 - June 30	2	3	0.02	2.0	21.6	32.4	0.2

5. Wasteload Allocation

The wasteload allocation is determined by:

(loading capacity) - (margin of safety) - (load allocation) - (held in reserve) = wasteload allocation

These TMDLs establish that zero loading is held in reserve for future growth for the three pollutants.

The wasteload allocations for the three pollutants are summarized in the tables below:

WASTELOAD ALLOCATIONS AT END-OF-PIPE FOR CBOD

	Loading capacity (lb/da)	Margin of safety (lb/da)	Load allocation (lb/da)	Wasteload allocation (lb/da)
July 1 - Oct.31	293	29.3	0	263.7
Nov. 1 – April 1	732	73.2	21.6	637.2
April 1 – June 30	732	73.2	21.6	637.2

WASTELOAD ALLOCATIONS AT END-OF-PIPE FOR NFR

	Loading capacity (lb/da)	Margin of safety (lb/da)	Load allocation (lb/da)	Wasteload allocation (lb/da)
July 1 - Oct.31	585	58.5	0	526.5
Nov. 1 - April 1	878	87.8	32.4	757.8
April 1 - June 30	878	87.8	32.4	757.8

WASTELOAD ALLOCATIONS AT END-OF-PIPE FOR NH3 as N

	Loading capacity (lb/da)	Margin of safety (lb/da)	Load allocation (lb/da)	Wasteload allocation (lb/da)
July 1 - Oct.31	41	4.1	0	36.8
Nov. 1 - April 1	88	8.8	0.2	79
April 1 - June 30	88	8.8	0.2	79

6. Margin of Safety (MOS)

The margin of safety accounts for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA § 303(d)(1)(C). 40 C.F.R. §130.7(c)(1).

There is not enough data to determine the uncertainty of the link between the loading capacities and the applicable water quality standards for this segment. Therefore, a 10% margin of safety was selected for all pollutants. If these TMDLs are reopened, the margin of safety will be reevaluated. The margins of safety for the loading capacity as determined at the end of the pipe are summarized in the table below:

END-OF-PIPE LOADING CAPACITY MARGIN OF SAFETY

	CBOD5 (lb/da)	NFR (lb/da)	NH_3N (lb/da)
July 1- Oct. 31	29.3	58.5	4.1
Nov.1 – March 31	73.2	87.8	8.8
April 1- June 30	73.2	87.8	8.8

7. Seasonal Variation

Seasonal variation has been addressed by establishing seasonal wasteload allocations at the California South Lagoon.

Seasonal limits for BOD and Ammonia are necessary because decay of these substances is biologically mediated and varies with water temperature and because dissolved oxygen gas saturation varies with water temperature. The impact of suspended solids on the receiving stream is primarily physical (smothering of natural stream substrate) and is not related to water temperature or other seasonal effects

8. Monitoring Plan for TMDLs Developed under the Phased Approach

The North Moreau Creek TMDLs are phased TMDLs. DNR plans two water quality surveys of the stream during summer low flow conditions in 2002. If those surveys show the stream is in compliance with water quality standards, the TMDL will be considered complete. If the surveys show exceedences of water quality standards, the results of these studies will be used to reevaluate these TMDLs and use the revised allocations to reissue new limits that will assure that the applicable water quality standards will be met.

9. Implementation Plans

These TMDLs will be incorporated into Missouri's Water Quality Management Plan.

On February 26, 1999, Missouri DNR re-issued NPDES MO 0023272 for the California South lagoons. This permit required that water quality based limits for BOD, NFR and ammonia be consistent with the Analysis of Effluent Needs done in February 1998. The permit requires these water quality based limits to be met by February 1, 2000. If future monitoring shows that water quality standards are not being met, then this TMDL will be reopened and reevaluated, and the permit will be reissued with new limits that assure that applicable water quality standards will be met.

10. Reasonable Assurances

Because the source of the instream impairment is a point source discharge regulated by an NPDES permit, Missouri DNR has adequate authority to require the necessary level of treatment at this facility.

11. Public Participation

Missouri DNR published a Public Notice on May 28, 1999, announcing the availability of the draft total maximum daily load (TMDL) analysis for the North Moreau Creek. The department invited the general public and any interested parties to review the report and send their comments through July 2, 1999. No comments were received. Six public meetings to allow input from the public on impaired waters were held between August 18 and September 22, 1999. There were no comments received on North Moreau Creek.

12. Administrative Record

An Administrative Record for these TMDLs is being maintained by the Missouri DNR.

13. Data and Information Sources

The Environmental Services Program (ESP), in cooperation with Water Pollution Control Program collected all chemical and flow data pertaining to the impaired stream segment.

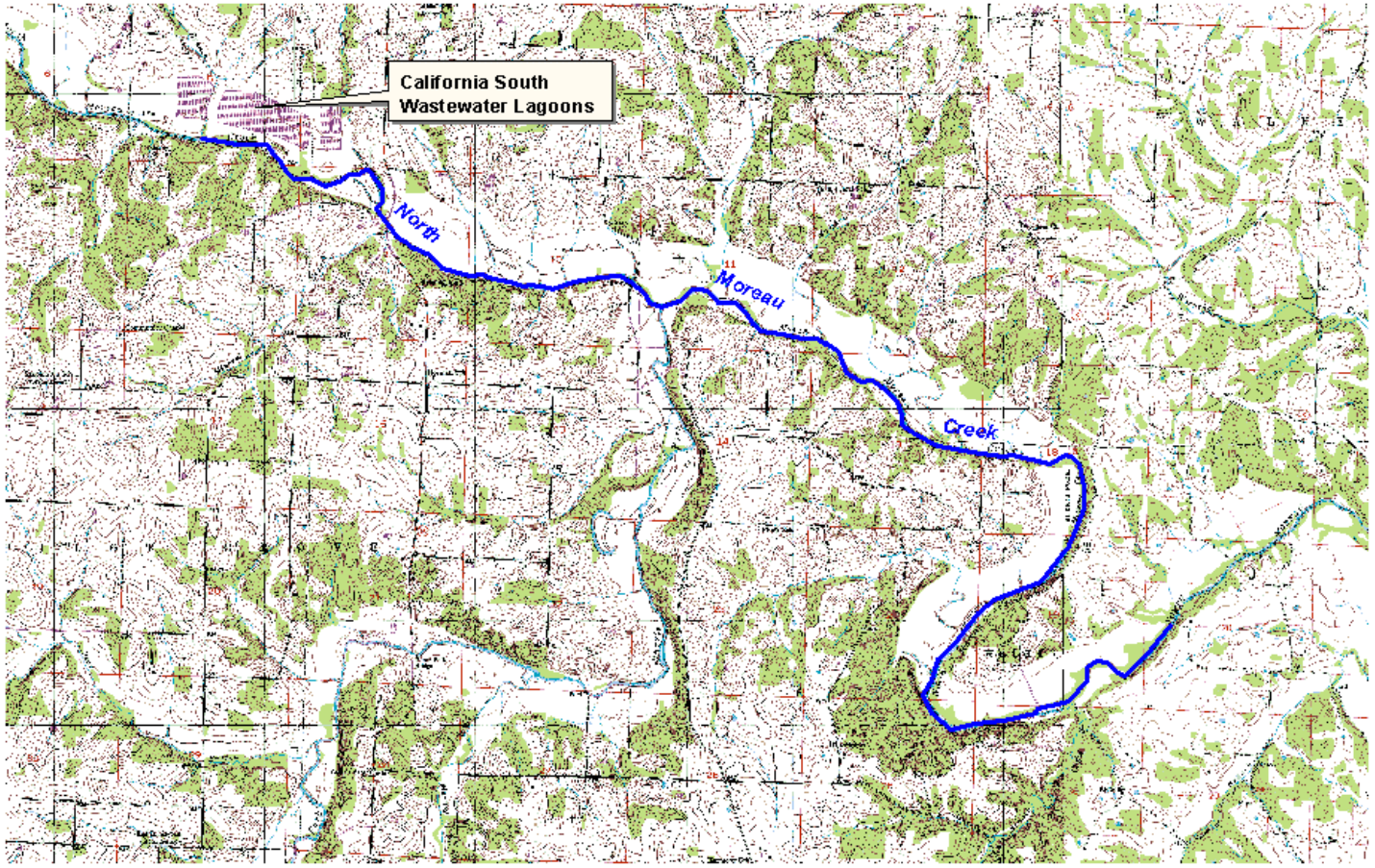
Appendix One: CBOD and Ammonia Limits derived from the Qual2e Model for Nineteen Streams.

The streams below were all modeled by Missouri DNR using Qual2e at low flow summer and winter conditions. Recommended effluent limits based upon model predictions are shown.

Stream	Facility	7Q10 Low flow (cfs)	Summer		Winter	
			CBOD	NH3N	CBOD	NH3N
Turkey Cr.	Joplin Turkey Cr.	0.1	10	2.5	10	3.0
Bear Cr.	Hannibal	0.0	16	4.0	25	4.0
Wolf Cr.	Farmington E.	0.0	20	5.0	20	5.0
St. Francis R.	Farmington W.	0.1	10	1.3	25	2.6
Walnut Cr.	El Dorado Springs	0.0	10	1.8	25	3.5
East Cr.	Belton	0.0	12	3.0	20	4.0
Perche Cr.	Columbia	0.5	10	1.5	10	2.0
Trib. Coon Cr.	Moberly	0.0	15	3.0	25	3.5
S. Fk. Salt R.	Mexico	0.0	10	2.0	20	2.0
Salt Fork	Marshall	0.1	10	2.0	10	3.0
W. Fk. Niangua R.	Marshfield	0.0	25	1.4	25	2.2
Hubble Cr.	Jackson	0.0	10	2.0	10	3.0
Todd Cr.	Kansas City Todd Cr.	0.0	10	2.5	15	3.5
Plattin Cr.	Festus	0.5	15	2.5	25	3.4
Brushy Cr.	Sedalia W.	0.0	10	2.5	20	3.5
L. Dry Fk.	Rolla SE	0.0	5	2.0	5	3.0
Elkhorn Cr.	Montgomery City	0.0	20	2.4	25	3.6
Williams Cr.	Mt. Vernon	0.9	5	2.0	10	3.0
Clear Cr.	Monett	0.0	5	2.8	10	3.8

References Maintained as Administrative Record

1) NPDES permit # MO 0023272
2) Analysis of Effluent Needs, February 1998



North Moreau Creek, Moniteau County, MO
TMDL:NFR, CBOD, & NH3

0.5 0 0.5 Miles

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